

This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

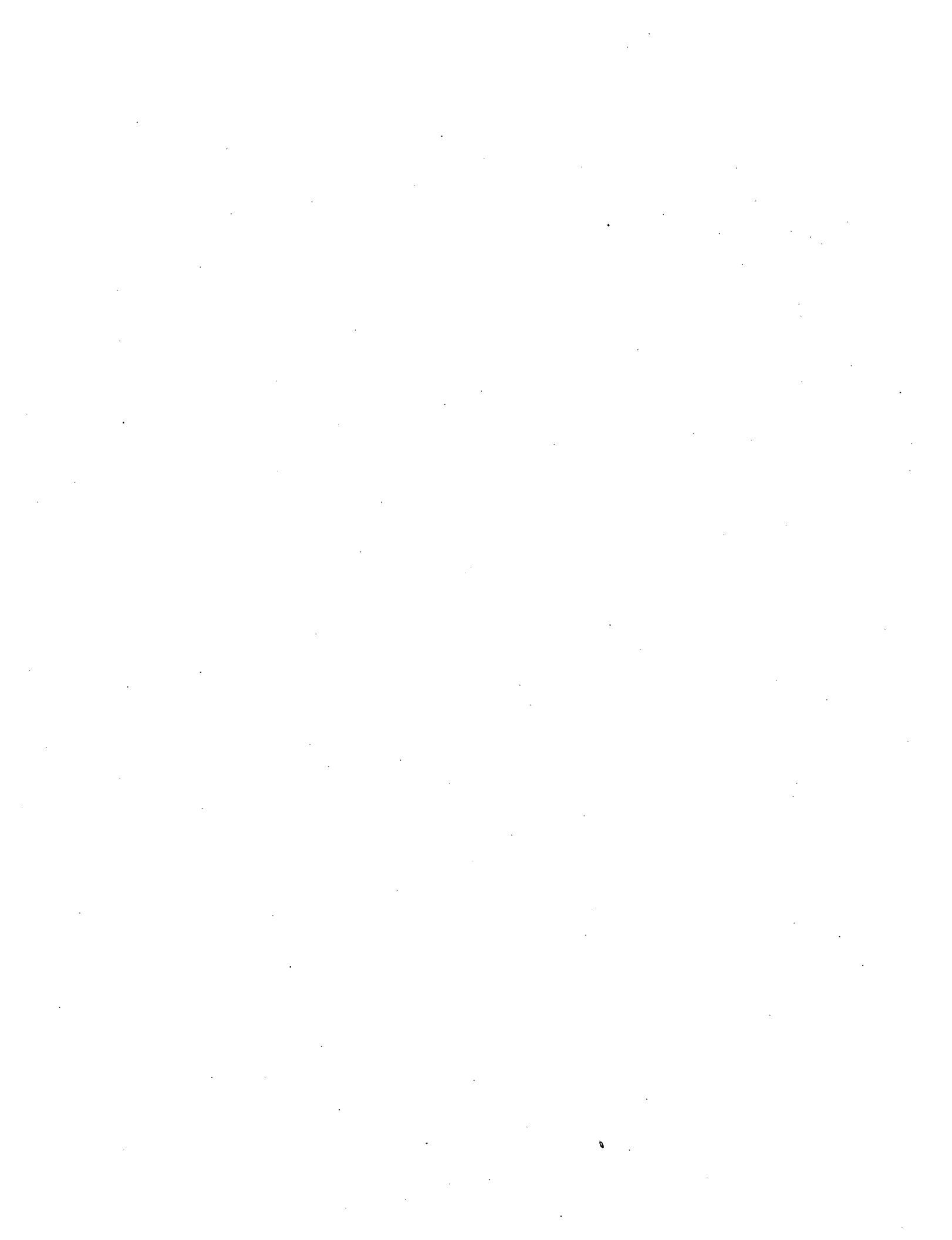
Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

**As rescanning documents *will not* correct images,
please do not report the images to the
Image Problem Mailbox.**





(19)

Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 0 851 531 A2

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
01.07.1998 Bulletin 1998/27

(51) Int. Cl.⁶: **H01Q 1/40, H01Q 1/52,**
H01Q 9/04, H01Q 23/00

(21) Application number: 97310161.1

(22) Date of filing: 16.12.1997

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC
NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 23.12.1996 GB 9626737
20.01.1997 GB 9701064

(71) Applicant:
NOKIA MOBILE PHONES LTD.
02150 Espoo (Fi)

(72) Inventors:
• Hicks, David
Ewell, Surrey (GB)

- **Davidson, Brian**
Woking, Surrey, GU21 3QD (GB)
- **Orchard, Lee**
Rowledge, Farnham, Surrey, GU10 4TF (GB)

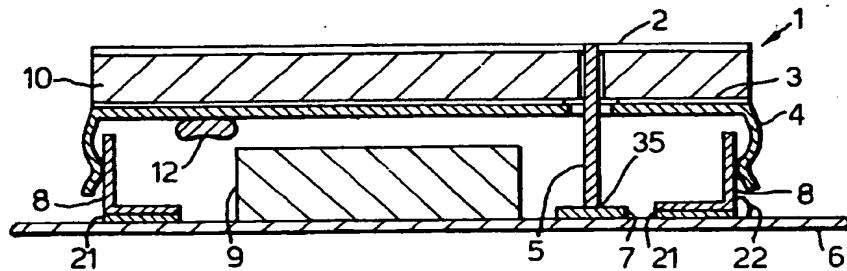
(74) Representative:
Potter, Julian Mark et al
Nokia Mobile Phones,
Patent Department,
St. Georges Court,
St. Georges Road,
9 High Street
Camberley, Surrey GU15 3QZ (GB)

(54) Antenna assembly

(57) An antenna assembly comprising: an antenna; a circuit unit; and a device cover for connection between the antenna and the circuit unit to electrically couple them.

antenna to the circuit unit.

Fig.8.



Description

This invention relates to an antenna assembly.

Antennas are used in many electronic products.

There is a need to streamline and reduce the cost of assembly of antennas, especially in high volume consumer products such as radio telephones. An antenna is typically soldered or screwed into place. This is time-consuming and requires special equipment. Then electrical feed and ground connections to the antenna are typically provided separately, in a similar way, requiring further manufacturing steps and connecting materials. One aim is therefore to simplify the connection of an antenna, preferably also reducing the number of components required.

According to the present invention there is provided an antenna assembly comprising: an antenna; a circuit unit; and a device cover for connection between the antenna and the circuit unit to electrically couple the antenna to the circuit unit.

The device cover is suitably a shield, preferably a shield against electromagnetic radiation, and most preferably a shield for an electronic device. The device cover preferably performs a shielding function in addition to providing a connection to the antenna.

The device cover is preferably a cover for an electronic device, for example an integrated circuit, most preferably for a single electronic device. The device cover preferably covers one or more devices that are connected directly or near (in terms of an electronic circuit) to the antenna and/or that form part(s) of a radio transceiver circuit, e.g. a synthesiser.

The device cover preferably comprises electrically conductive material. That electrically conductive material preferably at least defines a track for connecting the antenna to the opposite surface) to allow a second circuit element of the antenna furthest from the circuit unit (for example the radiating surface) to be coupled to the circuit unit. When the antenna and the circuit unit are brought together the coupler preferably makes contact with a second antenna connection region of the circuit unit. Preferably the second antenna connection region is for providing the electrical feed to the antenna or for grounding the antenna.

Preferably the antenna is substantially planar. Preferably the antenna is a planar antenna. Preferably the antenna is a PIFA (planar inverted F antenna) antenna.

According to the present invention from a second aspect there is provided a method of connecting an antenna to a circuit unit, the method comprising: deforming at least part of the antenna so as to connect the antenna to a first retaining member; and resiliently engaging the first retaining member with a second retaining member associated with the circuit unit.

The deformation is preferably conducted under the influence of heat. The antenna is preferably heat staked to the first retaining member, most preferably by the deformation of a projection of the antenna following

insertion of the projection through a corresponding recess or hole in the first retaining member. Preferably, the first and second retaining members, when assembled together, constitute a device cover and/or shield.

The present invention will now be described by way of example, with reference to the accompanying drawings, in which:

- 5 figure 1 is a top view of an antenna, the cross hatching indicating electrically conductive plating;
- 10 figure 2a is an end view of the antenna of figure 1;
- 15 figure 2b is a top view of the antenna of figure 1;
- 20 figure 2c is a side view of the antenna of figure 1, including a partial cross-section on the line B-B in figure 2b;
- 25 figure 2d is a bottom view of the antenna of figure 1, the shaded area indicating a region free from electrically conductive plating;
- 30 figure 3a is a top view of a device cover;
- 35 figure 3b is an end view of the device cover of figure 3a;
- 40 figure 3c is a side view of the device cover of figure 3a;
- 45 figure 3d is a cross-section on line A-A in figure 3c;
- 50 figure 3e is a cross-section on lines B-B in figure 3c;
- 55 figure 3f is a detail around the finger marked C in figure 3a;
- 60 figure 3g is a cross-section on line D-D in figure 3a;
- 65 figure 4 is a cross-section of a sprung connector pin;
- 70 figure 5a is a view of the antenna of figure 1 (together with the pin of figure 4) and the device cover of figure 3a prior to assembly;
- 75 figure 5b is a view of the same parts after having been assembled together;
- 80 figure 6 is a cross-sectional view illustrating heat staking of the antenna to the device cover; and
- 85 figure 7 is a partial view of a circuit board with installed components;
- 90 figure 8 is a cross-sectional view of a circuit board with an antenna and a device cover installed;
- 95 figure 9 shows an alternative embodiment of the cover.

Figure 8 shows an antenna 1 having radiating 2 and ground 3 regions of electrically conductive material. The antenna is fixed to device cover 4 which is in contact with the ground region 3. The antenna has a sprung pin 5 which is in contact with the radiating region 2. Underlying the antenna 1 is a circuit board 6 which has an electrical feed pad 7, connected to circuitry intended to provide an electrical feed to the antenna, and a lower cover member 8 which is coupled to ground of the circuit board. The device cover 4 and the lower cover member 8 are electrically conductive. When the antenna 1 (together with the device cover 4) and the circuit unit are brought together the device cover 4 engages the lower cover member 8, holding the antenna to the circuit

board 6 and making a ground connection between the circuit board and the antenna. At the same time the sprung pin 5 is compressed between the antenna 1 and the feed pad 7, making an electrical feed connection to the antenna 1. The device cover 4 and the lower cover member 8 act as a shield for electronic components 9 contained within them.

The antenna 1 is shown in detail in figures 1 and 2a to 2d. The antenna is a plate antenna comprising a core 10 moulded of non-conductive thermoplastic material (such as the plastics material Ultem 2300) selectively plated with electrically conductive material (for example with successive layers of copper, nickel and gold). The core has two holes 11a, 11b running through it from one major surface to the other. Two cylindrical pegs 12 integral with the core extend from major surface 13 of the core. For orientation purposes one corner of the antenna is chamfered. Typically, the dimensions of the antenna may be 16mm x 35.5mm x 3.2mm.

Substantial areas of both major surfaces 13, 14 of the core are plated. The plating on surface 13 defines the ground plane of the antenna. All of that surface is plated apart from an annulus 11c around through-hole 11b (the region shaded in figure 2d). The pegs 12 are uncoated. The plating on major surface 14 defines the radiating surface of the antenna. All of that surface is plated apart from slots 15 designed to increase the electrical length of the antenna for tuning purposes. The edge surfaces of the core are unplated but the interiors of through-holes 11a, 11b are plated, so the ground plane and the radiating surface are connected electrically together via the plating of through-hole 11a.

The connector pin 5 is shown in detail in figure 4. It comprises two concentric cylindrical metal tubes 5a, 5b arranged so that one can telescope inside the other. A coil spring 5c concentric with the tubes biases the extreme ends of the pin apart. The extreme ends of the pins are closed. The pin is coated with gold for good electrical conductivity.

The device cover 4 and the lower cover 8 form an electromagnetic RF shield for the synthesiser 9a of the transceiver circuit of a radio-telephone. The members of the shield are made of metal plate and could be manufactured by die stamping.

Alternatively they could be made of plastic coated all over or selectively with electrically conductive material.

The lower cover 8, which constitutes the lower member of the RF shield, has a planar frame 16 and four walls 17, 18, 19, 20 which are folded upwards from the frame. When the lower cover is installed on the circuit board 6 it is installed around the expected location of the synthesiser 9a so that the four walls 17-20 surround the synthesiser once manufacture is complete. The lower cover 16 is grounded. This may be done by means of a grounding wire; or preferably the frame 16 makes contact with a ground region 21 on the circuit board, and for a better connection is also soldered to

that region (e.g. at 22). The frame may be physically fixed to the circuit board by numerous methods, such as soldering and/or the bending of tabs passed through holes in the circuit board.

The upper cover 4 (shown in detail in figures 3a to 3g), which constitutes the upper member of the RF shield, has a generally planar top section 25. Parallel flanges 23, 24, each of which comprises five sub-flanges (e.g. 23a-e) are folded down from the side edges of the top section and are spaced so as to be able to engage the outside surfaces of walls 18, 20 of the lower cover. The flanges are resiliently deformable with respect to the top section and converge slightly so as to be able to pinch and grip the walls 18, 20 when the upper cover is pushed on to the lower cover. The distal ends 26, 27 of the flanges are flared so as to aid location of the flanges around the walls 18, 20. Location lugs 28, 29 are folded down from the top section and are spaced so as to fit neatly between walls 17, 19 and thus assist in correct locating of the upper cover on the lower cover.

The top section 21 of the cover 4 is dimensioned to match the antenna. Eight fingers 30 are directed upwards from the top section. The inclination of the fingers is resiliently deformable so that even if the fingers are pressed so as to lie in the plane of the top section they will exert a force upwards from the plane.

The cover 4 has four holes 31, 32, 33, 34 through the top section. Holes 31, 32 are spaced and dimensioned to correspond to the spacing and dimensions of the pegs 12, and located so that the pegs can fit through those holes with the sides of the antenna 1 generally flush with the sides of the cover 4. Both the pegs 12 and the holes 31, 32 are arranged symmetrically so that the device cover 4 and the antenna 1 can be fitted together successfully in two orientations (one rotated by 180 degrees with respect to the other), making the operation of assembly easier. Holes 33, 34 are to allow the sprung pin 5 to pass through the device cover 4. (Two holes are provided so that this can be done with the cover in either orientation relative to the antenna). The diameter of the holes 33, 34 is larger than that of the sprung pin 5 to ensure that the cover 4 and the pin 5 do not make contact (shorting the antenna) or even otherwise couple together undesirably.

The operation of assembly of the shield and antenna will now be described.

First, the sprung pin 5 is inserted in hole 1b in the antenna core 10 so that it is lodged in place with one extreme end of the pin flush with the upper surface 14 of the antenna and the other end of the pin projecting from the ground plane of the antenna generally perpendicularly to the ground plane. The diameter of the hole 10 matches the exterior diameter of the pin so that the pin can make an interference fit in the hole. To assist this further the hole 10 is tapered.

Next, the antenna 1 is married to the upper shield member 4 with the pegs 12 inserted through the holes

31, 32, the pin 5 inserted through one of the holes 33, 34, and the ground plane 3 of the antenna pressed against the cover so as to urge against the fingers 30. The urging of the fingers against the ground plane improves the electrical contact between the cover 4 and the ground plane. Ideally, the ground plane of the antenna is also in contact with the upper surface of the top plate 25 of the cover 4, so as to further improve the electrical connection between the two parts.

With the antenna and the cover 4 held together, a hot probe is forced against the tips of the pegs 12. The probe may itself hold the antenna and the cover together and hold the fingers 30 in compression. The probe softens the pegs and deforms them against the rear surface of the top section 25 of the cover 4 (see figure 6) to hold the antenna against the cover. The antenna 1 is thus heat staked to the cover 4. Alternative methods of deforming the pegs are impact staking and softening of the pegs using ultrasonic radiation.

Once the synthesiser 9a is connected to the circuit board 6, and the lower shield member 8 is fixed around the synthesiser and connected to the ground of the circuit board, the upper shield member 4 together with the antenna is pressed into place on the lower shield member 8. The location lugs 28 help to guide the cover into place; the flanges 23, 24 slide and grip against the side walls 18, 20 and the distal end 35 of the spring pin 5 makes contact with and is pressed into contact with the feed pad 7 on the circuit board. Thus the feed and ground connections to the antenna are made substantially simultaneously, in one operation, as the cover is moved (conveniently in a generally straight line) towards the circuit board. The movement of the cover relative to the circuit board is suitably substantially along the axis of the pin 5, although for the purpose of wiping the contact zone between the tip of the pin and the feed zone of the circuit unit there may be off-axis movement of the cover/antenna unit too. The flanges 23, 24 must have sufficient inward bias that the friction between them and the walls 18, 20 is sufficient to resist the biasing force of the spring 5c of the connector 5. To help ensure that the cover 4 will not come loose from the lower member 8 by vibration or under the action of the spring 5c the walls 18, 20 may be shaped to positively engage the flanges so that the cover 4 clips into engagement with the lower member 8.

If the antenna or the synthesiser need to be accessed, serviced or tested the antenna can easily be removed and replaced, together with the synthesiser shield cover 4. It is advantageous for the device under the cover 4 to be part of the transceiver circuit because it is relatively convenient to connect it to the antenna.

Examples of other embodiments of the invention will now be described. The shield could consist substantially of only an upper member which engaged, say, grounding pins on the circuit board. The upper shield member 4 may have flanges that engage every one of the side walls of the lower member 8. Extra retaining

means (such as additional clips) may be used to hold the upper member 4 on the lower 8. Alternatively, no such means may be provided. The pin 5 could be provided on the circuit board, pointing upwards, instead of on the antenna.

Figure 9 shows another embodiment of the antenna assembly. In this embodiment the shield consists of a shield unit 36 formed from metal. The antenna 37 has side clips 38 extending from its lower (ground plane) surface. Corresponding recesses 39 in the shield unit 36 accommodate the clips 38 allow the upper unit to be releasably but firmly engaged with the lower unit, with the metallisation of the ground plane held against the metal shield 36 to ground it effectively. The feed pin 40 of the antenna can then extend through the shield unit 36 to make contact with an antenna feed pad on an underlying circuit board.

The present invention may include any novel feature or combination of features disclosed herein either explicitly or implicitly or any generalisation thereof irrespective of whether or not it relates to the presently claimed invention or mitigates any or all of the problems addressed. In view of the foregoing description it will be evident to a person skilled in the art that various modifications may be made within the scope of the invention. The applicant hereby gives notice that new claims may be formulated to such features during prosecution of this application or of any such further application derived therefrom.

30

Claims

1. An antenna assembly comprising: an antenna; a circuit unit; and a device cover for connection between the antenna and the circuit unit to electrically couple the antenna to the circuit unit.
2. An antenna assembly as claimed in claim 1, wherein the device cover is a shield.
3. An antenna assembly as claimed in claim 2, wherein the shield is a shield against electromagnetic radiation.
4. An antenna assembly as claimed in any preceding claim, wherein the device cover is a cover for an electronic device.
5. An antenna assembly as claimed in any preceding claim, wherein the device cover comprises electrically conductive material.
6. An antenna assembly as claimed in any preceding claim, wherein the device cover is connected to the antenna.
7. An antenna assembly as claimed in any preceding claim, wherein the device cover is connected to the

circuit unit.

8. An antenna assembly as claimed in any preceding claim, wherein the circuit unit is a circuit board.

5

9. An antenna assembly as claimed in any preceding claim, wherein the device cover provides a ground connection to the antenna.

10. An antenna assembly as claimed in any preceding claim, wherein the device cover comprises a first cover member connected to the antenna and a second cover member connected to the circuit unit and releasably connectable to the first cover member.

10

15

11. A method of connecting an antenna to a circuit unit, the method comprising:

deforming at least part of the antenna so as to connect the antenna to a first retaining member; and

20

resiliently engaging the first retaining member with a second retaining member associated with the circuit unit.

25

12. A method as claimed in claim 11, wherein the deformation is conducted under the influence of heat.

13. A method as claimed in claim 11 or 12, wherein the said step of deformation includes the step of inserting a projection of the antenna through a corresponding recess in the first retaining member.

30

14. A method as claimed in any of claims 11 to 13, wherein the first and second retaining members when assembled together constitute a device cover.

35

40

45

50

55

Fig.1.

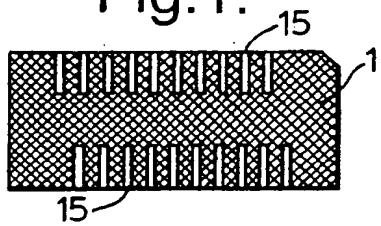


Fig.2a.

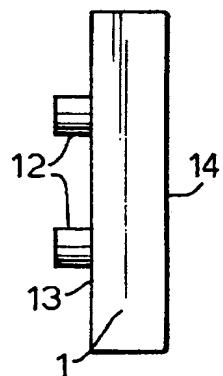


Fig.2b.

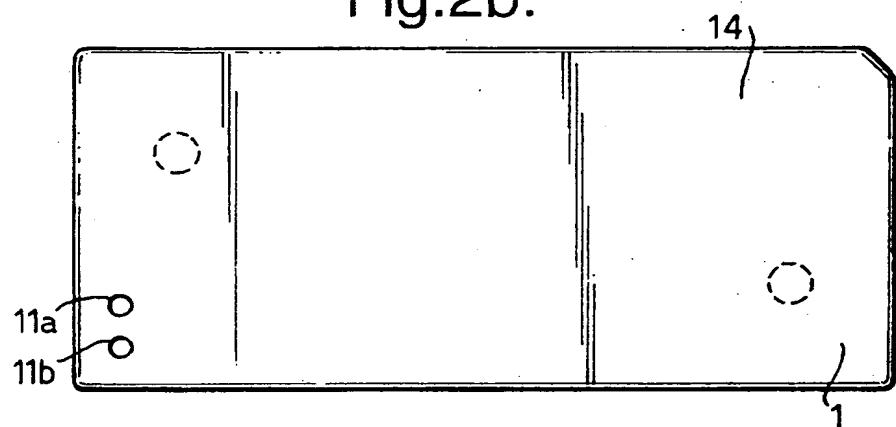


Fig.2c.

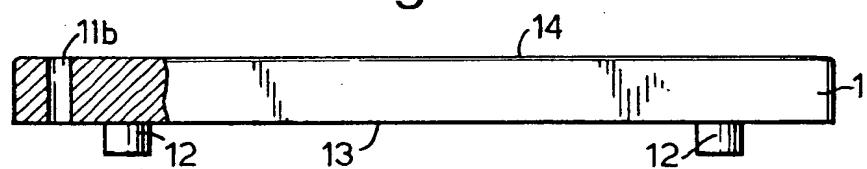


Fig.2d.

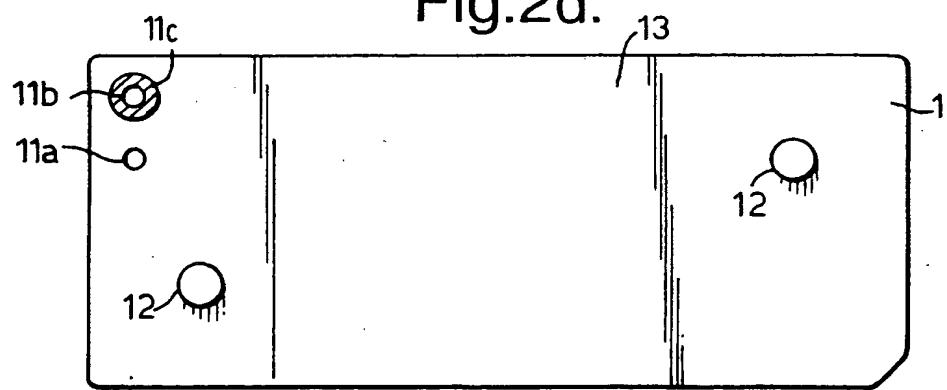


Fig.3a.

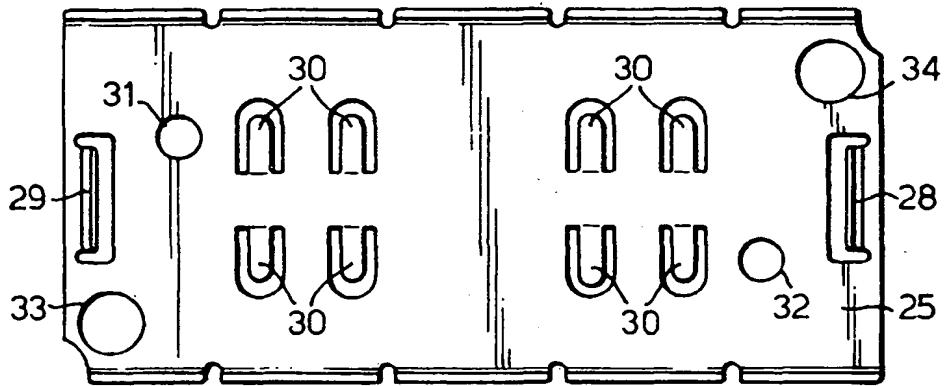


Fig.3b.

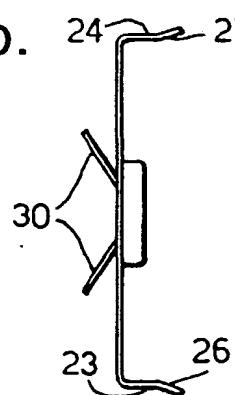


Fig.3c.

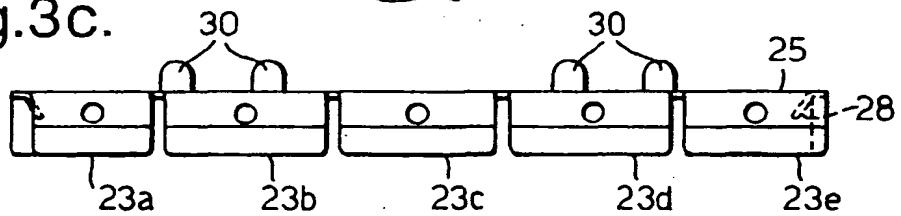


Fig.3d.



Fig.3e.



Fig.3f.

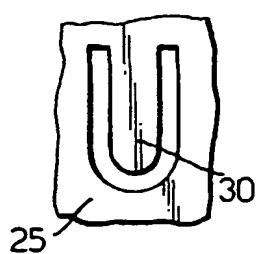


Fig.3g.

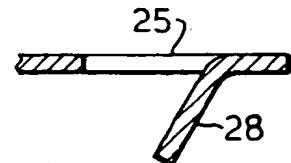


Fig.4.

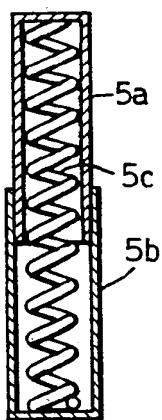


Fig.5a.

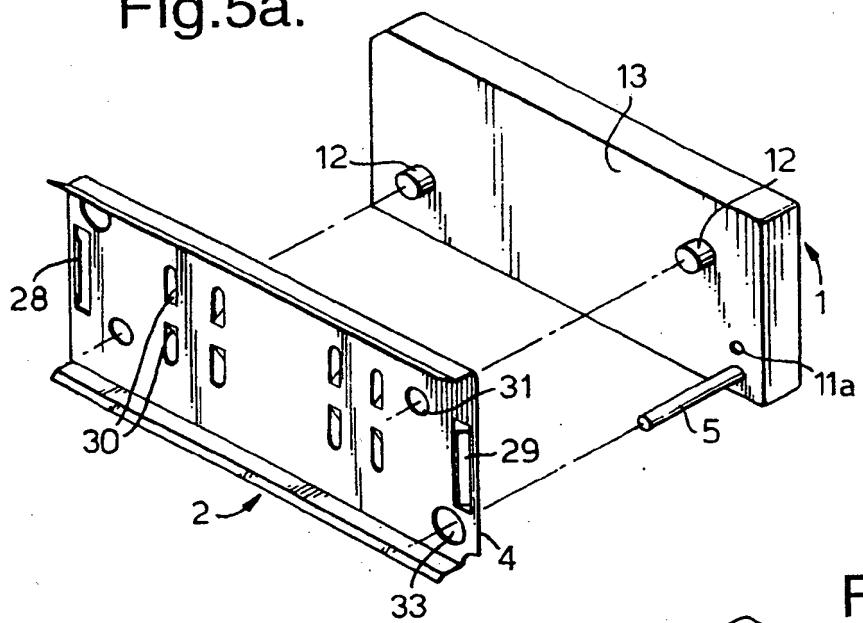


Fig.5b.

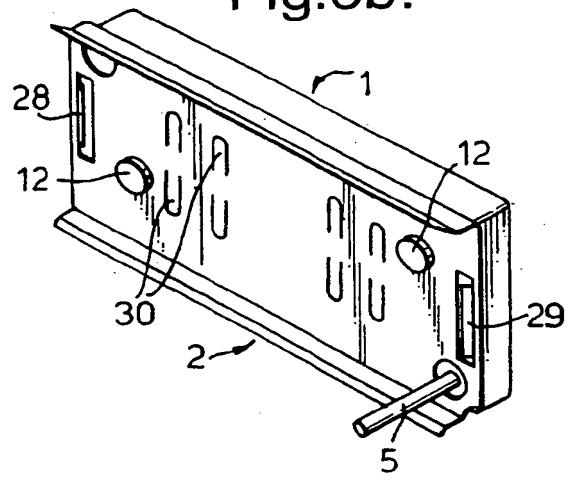


Fig.6.

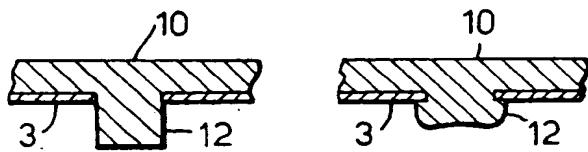


Fig.7.

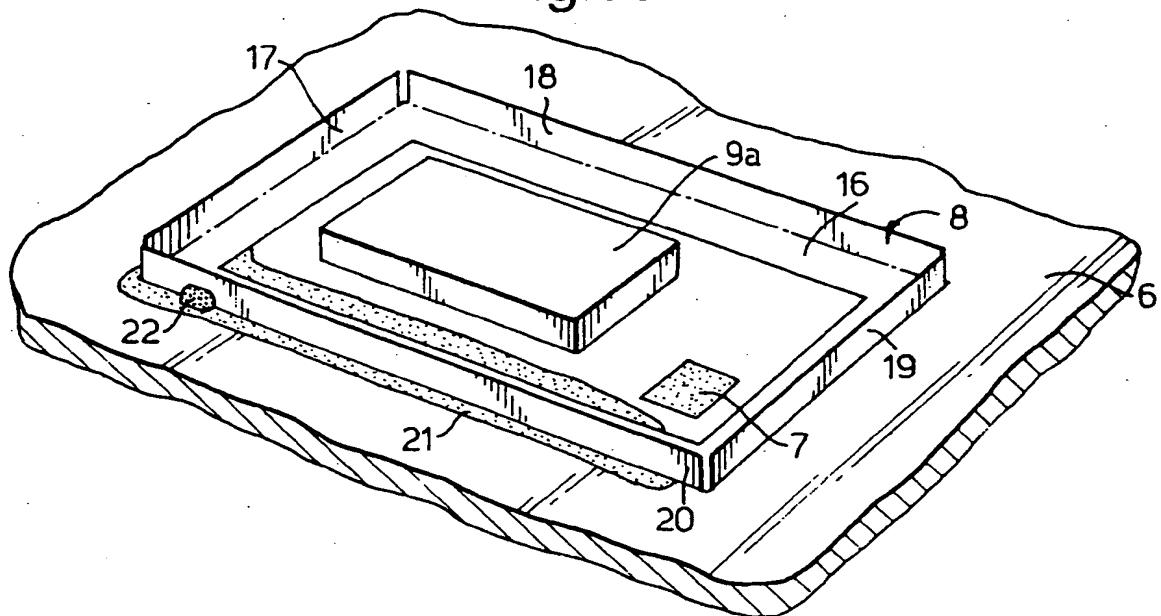
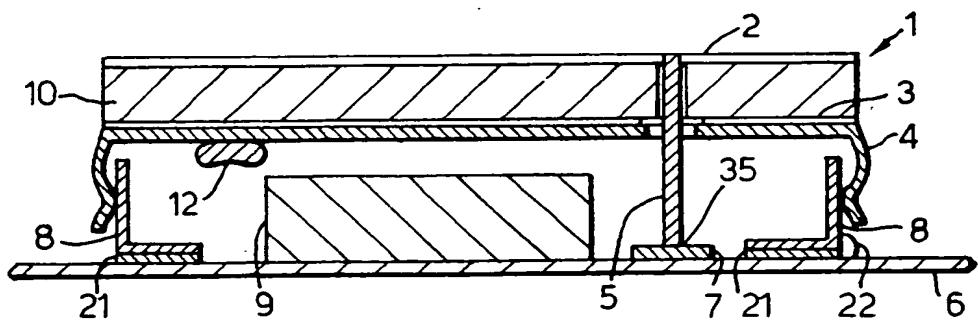


Fig.8.



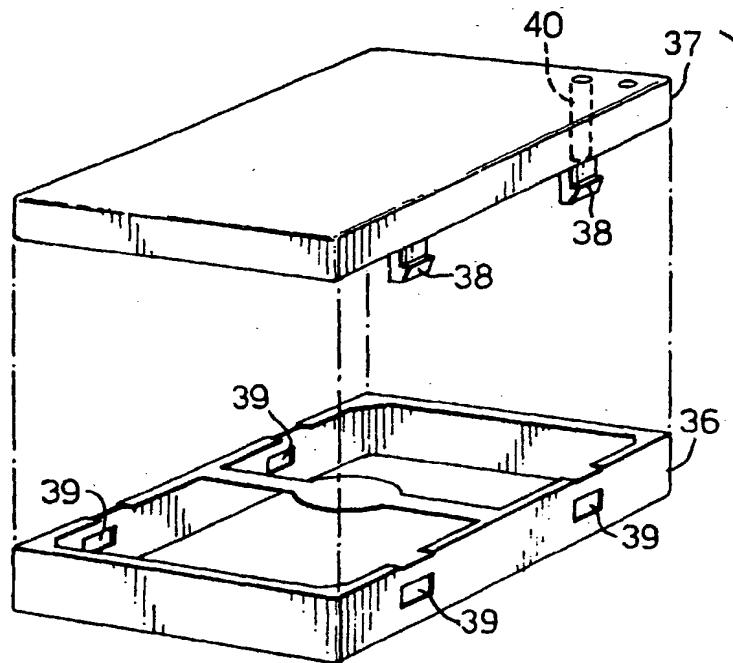
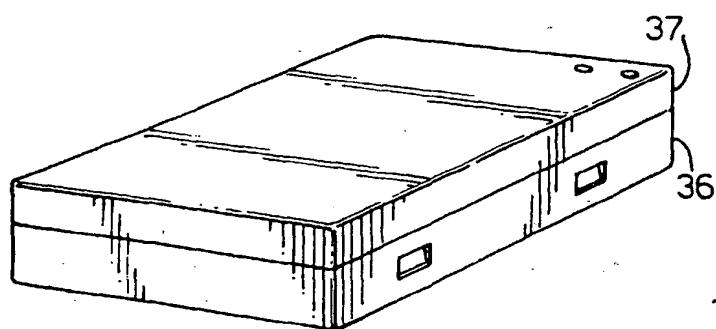


Fig.9.





(19)

Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 0 851 531 A3

(12)

EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
15.03.2000 Bulletin 2000/11

(51) Int. Cl.⁷: H01Q 1/40, H01Q 1/52,
H01Q 9/04, H01Q 23/00

(43) Date of publication A2:
01.07.1998 Bulletin 1998/27

(21) Application number: 97310161.1

(22) Date of filing: 16.12.1997

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC
NL PT SE

Designated Extension States:

AL LT LV MK RO SI

(30) Priority: 23.12.1996 GB 9626737
20.01.1997 GB 9701064

(71) Applicant:
NOKIA MOBILE PHONES LTD.
02150 Espoo (FI)

(72) Inventors:
• Hicks, David
Ewell, Surrey (GB)

• Davidson, Brian
Woking, Surrey, GU21 3QD (GB)
• Orchard, Lee
Rowledge, Farnham, Surrey, GU10 4TF (GB)

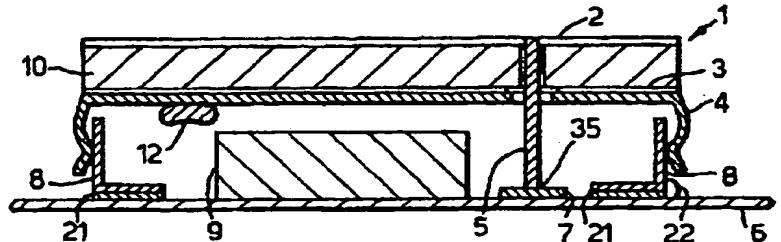
(74) Representative:
Potter, Julian Mark et al
Nokia Mobile Phones,
Patent Department,
St. Georges Court,
St. Georges Road,
9 High Street
Camberley, Surrey GU15 3QZ (GB)

(54) Antenna assembly

(57) An antenna assembly comprising: an antenna; a circuit unit; and a device cover for connection between the antenna and the circuit unit to electrically couple the

antenna to the circuit unit.

Fig.8.





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 31 0161

DOCUMENTS CONSIDERED TO BE RELEVANT					
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.CI.6)		
X	US 5 023 624 A (HECKAMAN DOUGLAS E ET AL) 11 June 1991 (1991-06-11) * column 1, line 6 - column 7, line 43 * * figures 1,3,5,7,9. * ---	1-10	H01Q1/40 H01Q1/52 H01Q9/04 H01Q23/00		
X	US 5 258 892 A (STANTON STEPHEN M ET AL) 2 November 1993 (1993-11-02) * the whole document *	1,2,4, 6-10			
A	---	11			
A	US 4 697 044 A (ISHIKAWA KEISUKE) 29 September 1987 (1987-09-29) * the whole document *	1			
A	EP 0 695 044 A (MATSUSHITA ELECTRIC IND CO LTD) 31 January 1996 (1996-01-31) * column 1, line 47 - column 6, line 7 * * figures 1,2,4-7 *	1			
A	EP 0 661 918 A (AT & T CORP) 5 July 1995 (1995-07-05) * column 2, line 18-25 * * column 3, line 52 - column 4, line 21 * * figure 3 * -----	1	<p>TECHNICAL FIELDS SEARCHED (Int.CI.6)</p> <p>H01Q H04B H05K</p>		
The present search report has been drawn up for all claims					
Place of search	Date of completion of the search	Examiner			
THE HAGUE	18 January 2000	Angrabeit, F			
CATEGORY OF CITED DOCUMENTS					
X : particularly relevant if taken alone	T : theory or principle underlying the invention				
Y : particularly relevant if combined with another document of the same category	E : earlier patent document, but published on, or after the filing date				
A : technological background	D : document cited in the application				
O : non-written disclosure	L : document cited for other reasons				
P : intermediate document	& : member of the same patent family, corresponding document				

ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.

EP 97 31 0161

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

18-01-2000

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 5023624	A	11-06-1991	NONE		
US 5258892	A	02-11-1993	NONE		
US 4697044	A	29-09-1987	DE 3447347 A	11-07-1985	
			GB 2152291 A, B	31-07-1985	
EP 0695044	A	31-01-1996	JP 8046384 A	16-02-1996	
			CN 1121681 A	01-05-1996	
			US 5636105 A	03-06-1997	
EP 0661918	A	05-07-1995	US 5557063 A	17-09-1996	
			DE 69409934 D	04-06-1998	
			DE 69409934 T	17-09-1998	
			JP 7212072 A	11-08-1995	

THIS PAGE BLANK (USPTO)